

Chem 321

Module 14: Calculation of the Buffer pH Using Activities

Buffer solution: mix 100 mL of 0.030 M KH_2PO_4 + 100 mL of 0.050 M K_2HPO_4

Solution

Since equal volumes of the solutions are mixed, the resulting concentration of each salt is just one-half of its starting concentration.

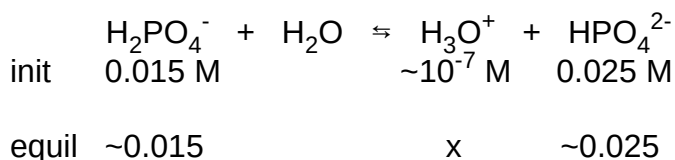
$[\text{H}_2\text{PO}_4^-] = 0.015 \text{ M}$, $[\text{HPO}_4^{2-}] = 0.025 \text{ M}$ and $[\text{K}^+] = 0.015 \text{ M} + 0.050 \text{ M} = 0.065 \text{ M}$

the ionic strength $\mu = \frac{1}{2}[(0.015 \text{ M})(-1)^2 + (0.025 \text{ M})(-2)^2 + (0.065 \text{ M})(+1)^2] = 0.090 \text{ M}$

for $\mu = 0.90 \text{ M}$,

$$\gamma_{\text{H}_2\text{PO}_4^-} = 0.82 - \frac{0.090 - 0.050}{0.050} (0.82 - 0.775) = 0.78_4$$

$$\gamma_{\text{HPO}_4^{2-}} = 0.445 - \frac{0.090 - 0.050}{0.050} (0.445 - 0.355) = 0.373$$



$$K_a = 6.3 \times 10^{-8} = \frac{a_{\text{H}_3\text{O}^+} a_{\text{HPO}_4^{2-}}}{a_{\text{H}_2\text{PO}_4^-}} = \frac{a_{\text{H}_3\text{O}^+} [\text{HPO}_4^{2-}] \gamma_{\text{HPO}_4^{2-}}}{[\text{H}_2\text{PO}_4^-] \gamma_{\text{H}_2\text{PO}_4^-}} = \frac{a_{\text{H}_3\text{O}^+} (0.025) (0.373)}{(0.015) (0.78_4)}$$

$$a_{\text{H}_3\text{O}^+} = 7.9_5 \times 10^{-8} \Rightarrow \text{pH} = -\log(a_{\text{H}_3\text{O}^+}) = 7.10$$